# Climate smart agricultural technologies and innovations for improved livelihoods of smallholder dairy and livestock farmers in Eastern and Central Africa region

## Introduction

Small-scale dairy and vegetable production plays a crucial role in food security, human health and overall household livelihoods, particularly among climate change prone, resource-poor households in Eastern and Central Africa (ECA) region. Zero grazing dairy systems are increasingly promoted, owing to progressive grazing land shortages and intensive dairy production requirements. Among the most affected are rural household food supplies, livestock feeds and water resources. The situation is exacerbated by community dependence on indigenous adaptation technologies with minimum scientific backup efforts. The lack of effective adaptation to the adverse effects of climate change is likely to jeopardise the achievement of Millennium Development Goals 1 (eradicating extreme poverty and hunger), 7 (ensuring environmental sustainability) and 3 (promoting gender equality and empowering women).

A regional project funded by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) region was thus designed and implemented in Burundi, Kenya, Tanzania and Uganda, with the following objectives:

(a) Develop economically feasible strategies for year-round feed supply to dairy cattle, in order to elevate household milk consumption (nutrition) and income sourcing;

(b) Increase availability of water for domestic uses, livestock production and drip irrigation, and investment of manure from smallholder dairy units into vegetable production, to provide quick income to the farmer and;

(c) Use existing regional communication infrastructure to enhance community awareness and knowledge about climate change manifestations and available, cost effective coping tactics in the region and elsewhere.

### Project sites

The project was conducted in Masaka, Ngora and Kumi districts of Uganda; Machakos, Wote peri-urban areas and around Wamunyu trading centre in Kenya; Bururi and Gitega provinces of Burundi and Ilemela and Nyamagana districts of Mwanza, Tanzania.

## Materials And Methods

The project targeted zero-grazing dairy farmers with 1-2 cows, at least 2 ha of land of which 0.5 ha was already planted with Napier grass fodder, a basal forage in intensive smallholder dairy systems. The following climate smart agricultural technologies and innovations were identified and evaluated on-farms using innovative systems approach.

### (a) Drought tolerant forages for year-round feed supply

The forage technologies involved mixtures of grass species (*Brachiaria* Hybrid cv. Mulato 1.; Giant Panicum or Napier) with forage legumes (*Desmodium intortum, Clitoria ternatea* or *Centrosema pubescens*). The forage technologies were compared with the farmers' practice of growing Napier grass alone. Compost manure from the feeding stalls was applied to the forage fields to improve forage yields. Farmers participated in all stages of project implementation to ensure instantaneous uptake of emerging knowledge and practices. The project involved 280 smallholder dairy vegetable growing farms, most of which had women as key players. The project supplied forage seed while the farmers provided labour to plant and manage the forage banks. Each of the beneficiaries of the technologies and innovations ensured multiplication and demonstration of promoted technologies to at least 20 new beneficiaries.

### (b) Homemade feed rations

Homemade nutrient feed block technology was introduced on-farm to provide dairy cattle with a cheap source of protein, energy and minerals. The blocks were made using farm waste and agro-industrial by-products.

### (c) Water harvesting innovations

Surface run-off and roof catchment water harvesting technologies and innovations were introduced on farms to improve water availability for agricultural and domestic use. The project provided dam liners and treadle pumps, while the farmers contributed labour to dig the pits and roofing materials.

### (d) Soil fertility enhancement and irrigation for vegetable production

Demonstrations established at farmer training schools and on selected farms, involved utilisation of cattle, goat or poultry manure for vegetable production. Compost manure was applied at a rate of 0 and 2.5 t $ha^{-1}$ on plots of 10m by 10m. Cabbage (*Brassica oleracea var.* Glory), Ethiopian eggplant (*Solanum aethiopicum*) and Sukumawiki (*Brassica integrifolia*

*var. carinata*) which are popular vegetables in ECA were used as the test crops. Drip irrigation using 50-100 litres per day was conducted using a plastic dram of 500 litres capacity as the reservoir; regularly perforated pipes laid out in the plots were used for regulated water delivery to the plants. Irrigation was routinely done at 6:00 and 18:00 hrs. The 'no manure or irrigation' plots constituted the control.

### (e) Labour saving technologies

Women and children are immense contributors to and beneficiaries from the dairy-vegetable production systems. Therefore, labour saving technologies and innovations such as simple fixed knife forage choppers were fabricated and distributed to farmers to reduce workload on chopping fodder. Hay balers were developed and distributed to enable farmers conserve fodder to ensure year-round vegetable supply.

## RESULTS

## Benefits from dairy and vegetable value chain technologies and innovations

### 1. Intercropping forage legumes with cereal crops

- Improved maize grain yield ensured food security.
- The crop residues provided a source of livestock feed during the dry season.
- Forage legumes provided a soil cover thus reduced moisture loss and improved soil fertility through nitrogen fixation.
- Forage legumes also controlled weeds and reduced the cost of weeding.



*Maize intercropped with forage legumes*



*a lady with big maize cobs from the intercrop*



*An intercrop of maize and forage legumes before harvesting the cobs*



*a family removing maize cobs and residues for livestock feeding*



*Drying maize cobs from the intercrop*

### 2. Drought tolerant forages and feed conservation

- Farmers were able to sustain about 45 kg of feed/cow/day through use of drought tolerant forages.
- Improvement in feed supply (quality and quantity) increased milk yield from about 6 litres/cow/day to 11 litres/cow/day.
- Improved feeding ensured better animal body condition and body weight.

- Animal fed high quality legumes provided manure of good quality.
- Environmental protection (erosion control, soil fertility improvement and a source of fuel wood).
- Tumbukiza (Micro water-catchment) pits withstood the long dry season and produced more herbage biomass (>10 t/ha) than the Napier grass planted without pits (<5 t/ha).



*Calliandra fodder trees*




*Brachiaria Hybrid cv. Mulato*



*Healthy Napier grass with manure application*



*Lablab hay*



*Tumbukiza" (micro catchments) pit*



*Lablab purpureus cv. Rongai (right) as a fodder and a cover crop*

### 3. Feed formulation using farm waste and agro-industrial by-products (Nutrient feed blocks)

- Milk yield increased by over 30% due to supplementation with high quality source of protein and energy.
- Reduced methane gas which is responsible for global warming.
- Commercial production of Nutrient feed blocks improved household income.



Orphans making Nutrient feed bocks for sale



A lady with a Nutrient feed block



A cow licking Nutrient feed block

## 4. Roof-top and surface run-off water harvesting

- Water harvesting enabled farmers to collect additional water for household use and livestock. In some households, up to 35,000 litres of water per season was collected. This was sufficient to cater for a family of four people keeping two lactating cows and irrigating 0.1 ha of vegetable plot for 4-6 months.
- About US $ 30 per month was saved on water bills.
- Family labour was shifted to other farm activities thus increasing overall farm productivity.



Construction of an underground tank using a dam liner



a completed tank Roof-top water harvesting innovation



Surface run-off water harvesting innovation



water lettuce planted on water surface helps to purify the water and reduces evapo-transpiration



*A village shallow well before the interventions*



*A village shallow well after the interventions*

## 5. Soil fertility improvement and irrigation for year round vegetable supply

- Vegetable yield increased by 500% as a result of irrigation and organic manure application.
- Vegetable revenue increased from US $ 20 to 150 per month.
- Vegetable residues provided highly nutritious residues for dairy cattle feeding.
- Investing cattle or poultry manure in vegetable production increased net returns by more than US $ 1,415 per ha per season.






*Small-scale vegetable production with manure from the grazing unit and irrigation using a treadle pump*



*Drip irrigation*



*Cows feeding on vegetable residues*

## 6. Post-harvest handling of dairy and vegetables products

- The richness of flavours and taste attained through processing attracted every consumer to value-added vegetables.
- Sale of processed vegetables increased household income.



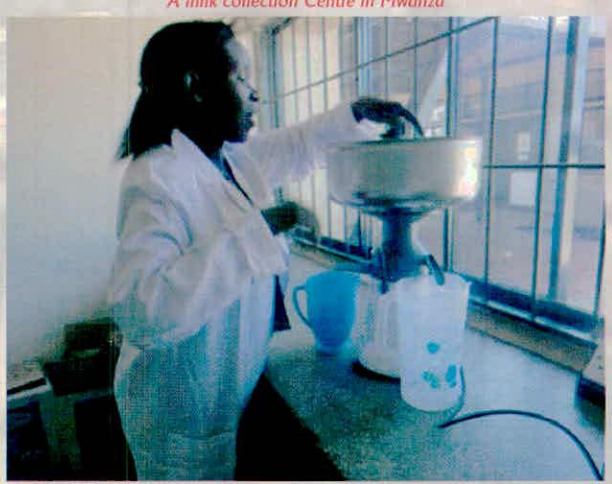
*A simple solar drier*



*processed vegetables ready for sale*



*A milk collection Centre in Mwanza*



*a technician being trained on ghee production*

### 7. Simple labour saving technologies

- Reduced workload.
- Chopping related accidents resulting from using hand shears or pangas were reduced.
- Increased feed utilisation by livestock and reduced wastage considerably due to small sizes of forages chopped.
- Different genders within the household can now chop forages for livestock and use the treadle pump to draw water from underground tank.
- A modified wooden hay baler enabled farmers to conserve excess fodder, reduced forage scarcity during the dry season and promoted efficient utilization of available forage for the dry season. Excess hay was sold to urban farmers with limited land.



*Chopping fodder before the interventions*



*A simple fixed knife forage chopper*



A user friendly treadle pump



Fixed forage knife chopper



A hay baler

## 8. Capacity building on improved technologies and innovations

- Over 5 million stakeholders were trained on "Climate smart agricultural technologies and innovations".
- The participatory approach stimulated households to exchange knowledge on appropriate technologies of integrating crop and livestock for increased productivity.



Young farmers



Farmers' agricultural show



Stakeholders during a review and planning meeting



Farmers are now able to exhibit the technologies to other stakeholders

## Other benefits

(a) Participating farmers reported that their success in the project activities attracted many other stakeholders from within and outside the country such as the visit of ASARECA Board of Directors and His Excellence, the President of Uganda to Masaka; Cabinet Ministers; Scientists; fellow farmers; Diplomats; Students; World Bank review mission and Members of Parliament.

(b) Consumption of milk improved nutrition of the children.




*A healthy child with a glass of milk*



*An old lady taking care of 17 orphans was able to build a new house using revenue from sale of milk and maize grain*

## COMMUNICATION STRATEGY, METHODS AND TOOLS USED FOR SHARING OUTPUTS AND IMPACT

(a) Workshops, field days, agricultural shows, print and electronic media, internet and scientific conferences enabled stakeholders and project research team members to learn new technologies and innovations and to increase the efficiency on their farms.

(b) ASARECA website (www.asareca.org) was used alongside e-mail, ICT tools (Skype, Google talk, YouTube, LinkedIn, Dropbox etc.) to share technical reports and research outputs with scientists involved in the project and with other partners at national, regional and international level.

(c) A 'One-Stop Climate Change Adaptation Dissemination Centre' where all technologies were demonstrated was established in each project site to educate stakeholders on climate change impacts and promote mitigation and adaptation strategies.

(d) Participatory approaches were employed in generation of information at the farmer level.

(e) Translation of some of the printed material into local languages was done to reach out to more farmers and increase adoption of the innovations.

(f) Two scientific conferences bringing together members of the established action research alliances at project sites and other partners were organized to share outputs and lessons from the project.

(g) Over 5 million stakeholders were trained on "Climate smart agricultural technologies and innovations".

## CONCLUSIONS

Drought tolerant forages elevated household production levels and lead to economic returns of about US $ 676.9 $cow^{-1}$ $years^{-1}$. Increased availability of household water for production through innovative rainwater harvesting, and utilisation of livestock manures, considerably extend the agronomic and socio-economic benefits to the communities, particularly through vegetable production.

Further studies are recommended to explore the best bet irrigation production efficiencies within the socio-economic frameworks of the affected communities, as a basis for further scaling out and up of these novel technologies across the region. In order to meet the high demand for the technologies, there is a need to establish forage seed multiplication sites and train local artisans on drip irrigation and water harvesting technologies. Relevant policies should be bolstered to enhance adoption of climate change coping technologies, as a strategy for improving livelihoods.

## ACKNOWLEDGEMENTS

This news letter is an output from a regional project *"Harnessing crop-livestock integration to enhance food security and livelihoods resilience to effects of climate variability and climate change in Eastern and Central Africa (LFP PRJ 12)* funded by ASARECA.

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